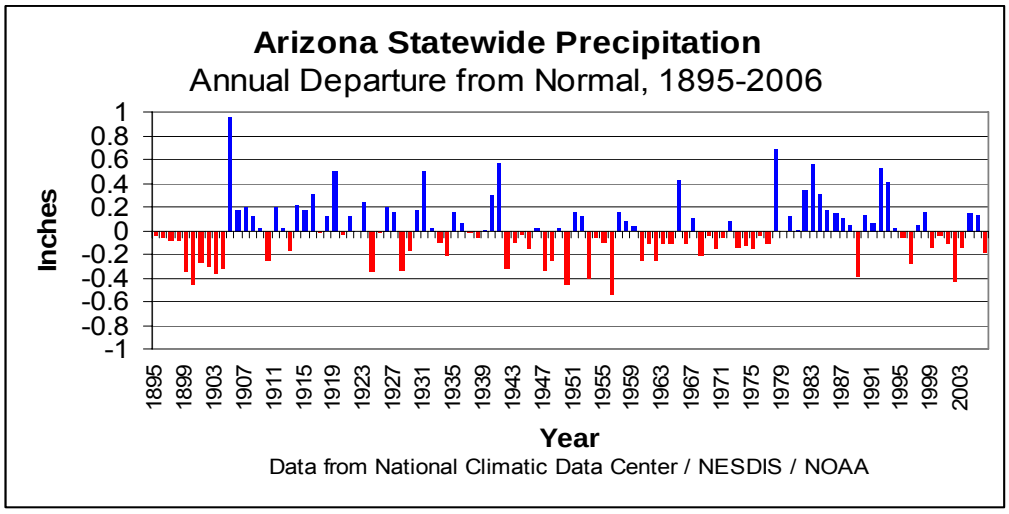
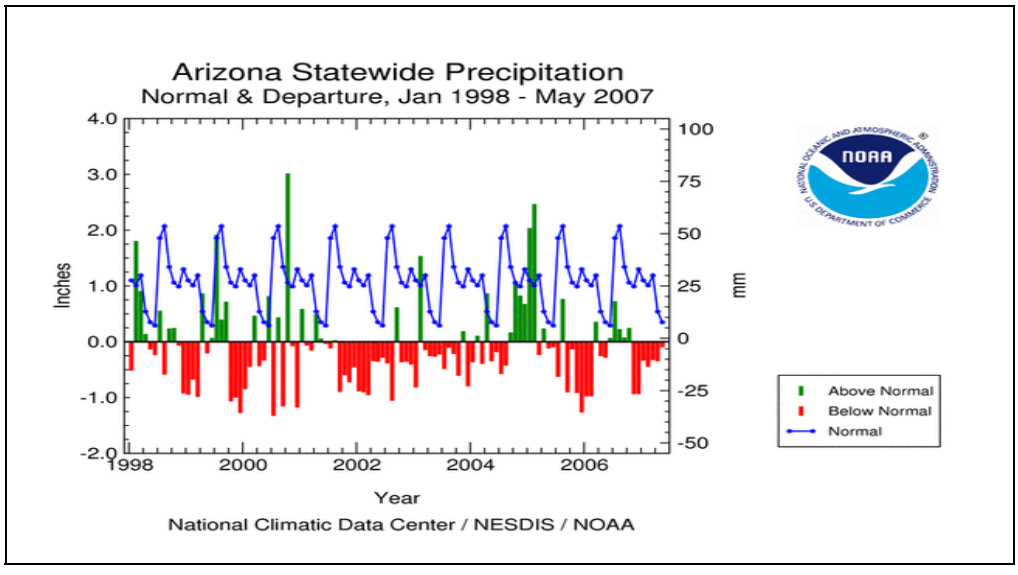
5.4.2 Drought

History

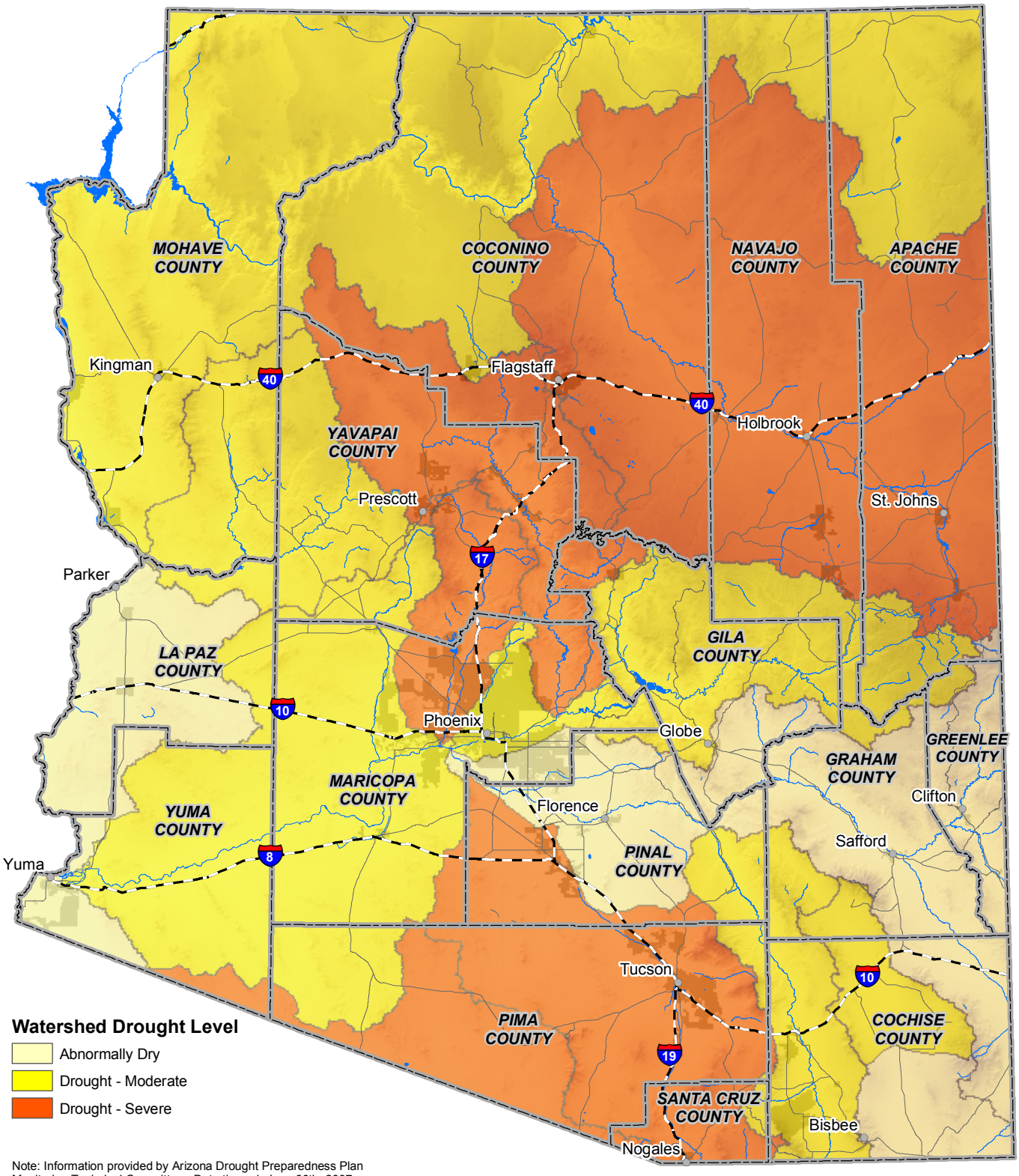
Arizona has experienced 17 droughts declared as drought disasters/emergencies and 93 drought events (droughts affecting multiple years are recorded as a distinct event for each year affected. Between 1849 and 1905, the most prolonged period of drought conditions in 300 years occurred in Arizona (NOAA, July 29, 2003). Another prolonged drought occurred during the period 1941 to 1965, during which time there were no spill releases into the Salt River (ADEM, December 2001). The period from 1979-1983 appears to have been anomalously wet, while the rest of the historical records shows that dry conditions are most likely the normal condition for Arizona. That characterization is supported by recent research on Arizona's historical climate using tree-ring records (Meko et al. 2007). The most recent data from NCDC (shown below), show that between 1998 and 2007 there have been more months with below normal precipitation than months with above normal precipitation. In the arid West, drought is characterized by extended periods of below normal precipitation, punctuated by occasional wet years. The current drought began in 1995, but conditions have worsened since mid 2001, with winter 2004 - spring 2005 as the only wet period.





Source: Arizona State Climate Office

State of Arizona



Note: Information provided by Arizona Drought Preparedness Plan Monitoring Technical Committee - Data through June 30th, 2007

Source: ADWR 2007; URS 2003; ALRIS 2006

Legend

- Major City
- interstate
- Highway
- Major Streams
- County
- Lakes
- Cities

N

0 25 50

Miles

August 2007

State of Arizona Multi-Hazard Mitigation Plan

Map 19
Long Term Drought Status Based on Watershed
as of July 2007

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

In 2003, Governor Janet Napolitano created the Arizona Drought Task Force, led by ADWR, which developed a statewide drought plan. The plan includes criteria for determining both short and long-term drought status for each of the 15 major watersheds in the state, based on precipitation and stream flow. The plan also calls for the establishment of local drought impact groups in each county to provide monthly impacts on agriculture, rangeland, and forest health at the local level. Twice a year the task force reports to the governor on the drought status and the potential need for drought declarations. The counties use the monthly drought status reports to implement drought actions within their drought plans.

While metropolitan Phoenix depends primarily on surface water stored in the Salt-Verde watershed reservoir system, most of the State relies on groundwater or Central Arizona Project (CAP) water from the lower Colorado River. The statewide drought plan also calls for all water providers to develop drought plans that include an assessment of risk for their water supply and action plans for conservation when drought reaches critical threshold levels in their water service area. Some of the actions include cutbacks in water delivery and elimination of non-critical water uses. In the case of short term drought, many ranchers throughout the State are faced with the choice of buying feed for their cattle or selling the herd. Arizona and New Mexico are assessed to have the poorest range and pasture land in the United States, so both long and short-term drought have significant consequences to ranchers as well as to wildlife.

Map 19

As displayed, drought representation was based on watershed areas that the AZ Drought Task Force issues monthly as a long-term status report. A watershed is a land area that drains water to a particular stream, river or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas of a map, often a ridge. Large watersheds, like the Colorado River basin contains thousands of smaller watersheds.

Probability and Magnitude

The National Drought Mitigation Center (NDMC) issues weekly national drought status maps for both the long and short term. The primary long-term indicators for the Western U.S. are the Palmer Hydrologic Drought Index, and the 60-month Palmer Z-index. No commonly accepted approach exists to assessing risks associated with drought. The Palmer Drought Severity Index (PSDI) is a commonly used index that measures the severity of drought for agriculture and water resource management. It is calculated from observed temperature and precipitation values and estimates soil moisture. However, the Palmer Index is not considered to be consistent enough to characterize the risk of drought on a nationwide basis (FEMA, 1997). Neither of the Palmer indices are well suited to the dry, mountainous western United States, so the Arizona Drought Task Force Technical Monitoring Committee uses the Standardized Precipitation Index (SPI - McKee et al., 1995) for the short-term drought status and a combination of the SPI and streamflow for the long-term drought status. This method is based on research by (Steinemann and Cavalcanti, 2006) for the Georgia drought monitoring program, and adapted to conditions in Arizona.

The entire State is susceptible to a drought at any time, though the drought season tends to be from January through May. According to recent climate modeling studies by researchers at Columbia University's Lamont-Doherty Earth Observatory, which are part of the International Panel on Climate Change (IPCC) 2007 report, the southwestern United States may become a dust bowl, reminiscent of the 1930s. Dr. Gerald Meehl of the National Cooperative for Atmospheric Research (NCAR), in a 2007 report to the IPCC, found that mega-droughts have occurred in the past and are likely to occur in the future, particularly in areas prone to monsoons, such as the Indian subcontinent and Southwestern North America. A recent study of past droughts (A.D. 762-2005) in the southwest using tree ring data (Meko, et al 2007) found that droughts in the past have lasted as long as 60 years, with reduced streamflow lasting an average of 25 years. The data suggest extended drought is the normal condition in the southwest, and the wet decades of the 1970s and 1980s are uncharacteristic.

It is notable that temperatures in the Western U.S. rose 2-5°F during the 20th century. While this increase was accompanied by precipitation increases of up to 50% in some areas of the West, some places have become drier and experienced more droughts (including Arizona). The most recent report by the IPCC predicts more variability in precipitation, and probably drier conditions over the next 50 to 100 years. However, even if precipitation does not decrease in the future, the higher temperatures will increase the evaporative demand for water and lead to more drought.

Arizona's desert climate directly affects our economy and quality of life. All economic activity, including mining, irrigated agriculture, and growth of cities occurs only where dependable water supplies are available. As a result, Arizona places a high priority on managing its limited water to ensure that secure water supplies are available now and well into the future.

There are basically four categories of water supplies available in Arizona: Colorado River water, surface water other than Colorado River water, groundwater and effluent. The utility of each type of water depends on its quantity, quality, reliability and economic feasibility. Surface water from lakes, rivers and streams is our major renewable resource. However, because of our desert climate, the amount of surface water available can vary dramatically from year to year, season to season, and place to place. In order to make the best use of the surface water when and where it is needed, storage reservoirs and delivery systems have been constructed throughout the State. Most notable are the major reservoir storage systems located on the Salt, Verde, Gila and Agua Fria rivers. Almost all of the natural surface water in Arizona has been developed.

A separate category of surface water in Arizona is the water supplied through the Colorado River. The federal government constructed a system of reservoirs on the river to harness its supplies for use in several states. Arizona, California, Nevada, New Mexico, Utah, Colorado, Wyoming and Mexico share the river's resources. Rights to use Colorado River water are quantified by a string of legal authorities known as the "Law of the River." Based on this body of law, Arizona has the right to use 2.8 million acre feet annually of Colorado River water. Mohave, La Paz and Yuma county water users rely on Colorado River as their principal water supply. When fully utilized, the Central Arizona Project will deliver on average 1.5 million-acre feet of Colorado River water to Maricopa, Pinal and Pima Counties.

About 36% of the State's water use comes from groundwater sources. Groundwater is found beneath the earth's surface in natural reservoirs called aquifers. In most cases the water stored in these reservoirs has been in place for millions of years. Throughout this century, groundwater has been pumped out more rapidly than it is being replenished, creating a condition called overdraft. Though a large amount of water remains stored in Arizona's aquifers, its availability is limited by location, depth and quality. By continuing to overdraft the State's groundwater supplies, we challenge our ability to ensure a secure water supply for the future. In recognition of this threat, Arizona implemented the Groundwater Management Code in 1980. The Groundwater Code promotes water conservation and long-range planning of our water resources.

Reclaimed water, or effluent, is the one increasing water source in our state. As our population and water use grows, more treated wastewater will be available. Reclaimed water is treated to a quality that can be used for purposes such as agriculture, golf courses, parks, industrial cooling, or maintenance of wildlife areas.

In 2006, Arizona used approximately 8.1 million acre-feet of water. One acre-foot equals 325,851 gallons. An acre-foot is enough water to serve the needs of a family of five for one year. The graph below shows the percentage of water used by each major use category.

Arizona Water Supply – Annual Water Budget 2006		
Water Source	Million Acre Feet (maf)	% of Total
Surface Water	4.2	51.7
Colorado River	2.8	34.5
CAP Canal	1.6	19.7
On-River	1.2	14.8
In-State Rivers	1.4	17.2
Salt-Verde	1.0	12.3
Gila & others	0.4	4.9
Ground Water	2.9	35.8
Reclaimed Water	1.0	12.3
Total	8.1 maf	100
Source: Arizona Department of Water Resources		

The heavily populated portion of Arizona is unique, particularly the major metropolitan areas of Phoenix and Tucson. While located in a region subject to hydrological drought, a large supply of water is available via the Central Arizona Project (CAP) Canal. The CAP Canal is a 336-mile long system of aqueducts, tunnels, pumping plants, and pipelines running from the Colorado River on the Arizona-California border eastward to the Phoenix area and then southeast to the Tucson area. The CAP Canal supplies approximately 1.5 million acre-feet of water annually to Maricopa, Pinal, and Pima Counties and is the largest single source of renewable water supply in the State. The CAP Canal has more than 80 major customers, approximately 75% of which are municipal and industrial users, 13% are irrigation districts, and 12% are Indian communities (ADWR; Central AZ Project).

In an attempt to categorize the probability of future events of drought, the hazard was analyzed using the CPRI. This method also takes into account the levels of magnitude/severity, warning time and duration. In Arizona, drought is highly likely, the magnitude/severity is typically limited, the warning time is more than 24 hours and the duration is always more than a week. These factors resulted in a CPRI rating of 2.95. The highest rating a hazard can result in using this method is 4.

Vulnerability

The impacts of drought to critical and non-critical facilities and building stock is generally indirect, in that drought is often a contributing factor to other hazards such as flooding, subsidence and wildfire. Extended drought may weaken and dry the grasses, shrubs, and trees of wildfire areas, making them more susceptible to wildfire. Drought also tends to reduce the vegetative cover in watersheds, and hence decreases the interception of rainfall and increases the flooding hazard. Subsidence conditions are aggravated when lean surface water supplies force the pumping of more groundwater to supply the demand without the benefit of recharging from normal rainfall. The sectors most directly impacted by drought are agriculture, ranching, potable water supplies, and recreation/tourism. The vulnerability and potential impact for this risk assessment will focus primarily on the potential economic impacts to Arizona's agriculture and domestic water supplies.

The most direct impacts are to the agricultural community, the development of domestic water supplies, and hydroelectric generation. The states primary sources of water for agriculture and domestic water supplies come from either the Central Arizona Project (CAP) which is supplied by the Colorado River Drainage Basin; Salt River Project network of dams and canal systems designed to supplement the Phoenix and Tucson area; and groundwater supplies are available for generally the rest of the State. Statewide public and private drinking water systems consist of over 4,000 groundwater wells and over 100 surface water intakes (AZDEQ, Water Quality database 2006). If the need for groundwater persists, the production and associated costs intensifies to meet EPA safe drinking water requirements. Both agricultural and electric utility resources can be affected during drought periods. With regard to agriculture, when drought conditions persist such as what is currently being experienced statewide, more demand is placed on groundwater supplies. Also, the additional groundwater pumping then translates into increased subsidence conditions.

From 1987 to 2002, the State has received well over $300,000,000 in disaster related assistance funding from the U.S Department of Agriculture for crop and livestock damages. According to the USDA, 35 to 55% of the disaster assistance money (USDA, 2004), in the last 10 years can be attributed to drought related losses. These impacts are translated into the general economy in the form of higher food and agricultural goods prices.

Other economic losses associated with drought could include increased domestic water supply costs, increased wildfire risk and firefighting costs, and exacerbation of subsidence conditions.

For the local risk assessment summary, the table below combines asset and predominantly HAZUS information for the estimated losses as reflected in local plans. The potential total # of facilities in the drought areas is 1,275,149 at a replacement cost of $238 billion. The estimated losses for drought according to local plans are approximately $51 million which include agricultural losses.

Summary of Local Risk Assessment & loss estimates based on Drought			
	Total Assets $ (Assets +HAZUS) x $1,000	# of Facilities Impacted (Assets + HAZUS)	Estimated Loss
Statewide Totals	$238,780,403	1,275,149	$51,010,000
Apache	-----	-----	$10,000,000
Cochise	-----	-----	-----
Coconino	-----	-----	$1,000,000
Gila	-----	-----	-----
Graham	-----	-----	$4,800,000
Greenlee	-----	-----	-----
La Paz	-----	-----	-----
Maricopa	$188,380,403	994,383	$9,600,000
Mohave	-----	-----	$510,000
Navajo	-----	-----	$15,000,000
Pima	$50,400,000	280,766	$2,100,000
Pinal	-----	-----	$2,500,000
Santa Cruz	-----	-----	$3,000,000
Yavapai	-----	-----	-----
Yuma	-----	-----	$2,500,000
----- Denotes lack of available information for assessment.			

Sources:

Arizona Governor Janet Napolitano, March 24, 2003. Executive Order 2003-12: Arizona Drought Task Force Plan.

AZ Dept of Environmental Quality, Water Quality database 2006.

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National Oceanic & Atmospheric Administration, July 29, 2003."Drought Information Center." http://www.drought.noaa.gov/

New Mexico. May 31, 2002. New Mexico Drought Plan.http://weather.nmsu.edu/drought/053102/

US Department of Agriculture:

- August 13, 1999."Glickman Declares Pennsylvania, 13 Arizona Counties as Disaster Areas and Announces Additional Drought Assistance." http://www.usda.gov/news/releases/1999/08/0334
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